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CLINICAL PHARMACY RESEARCH REPORT

How do pharmacists select antimicrobials? A model of pharmacists' therapeutic reasoning processes

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Abstract

INTRODUCTION: Clinicians engage in clinical reasoning, comprised of both diagnostic and therapeutic components, when caring for patients. While diagnostic reasoning has been extensively investigated, relatively few studies have examined how clinicians make treatment decisions. Recent work has explored how physicians engage in therapeutic reasoning while selecting antimicrobials. However, understanding pharmacists' antimicrobial reasoning is equally important due to their role in ensuring appropriate antimicrobial use. Therefore, we aimed to further our understanding of antimicrobial reasoning in pharmacists and compare their reasoning processes to physicians.

METHODS: With a postpositivist orientation and using a general qualitative approach, we conducted semi-structured interviews with hospital-based pharmacists specializing in infectious diseases or other hospital-based specialties. Participants narrated their thought processes while selecting antimicrobials for three case vignettes. We analyzed transcripts iteratively using a code book from a prior study of antimicrobial reasoning in physicians as a sensitizing framework.

RESULTS: Participants included 11 pharmacists (5 infectious diseases and 6 non-infectious diseases pharmacists). Overall, participants' responses reflected a three-step reasoning process: *Naming the Syndrome*, *Delineating Pathogens*, and *Selecting the Antimicrobial*. Patient-, syndrome-, and system-based factors interacted with drug characteristics to influence the selection of specific antimicrobial regimens.

CONCLUSION: We identified a framework for pharmacists' antimicrobial therapeutic reasoning similar to physicians' reasoning, with some nuances that may be attributable to the pharmacists' role in medication review and antimicrobial stewardship. Application of this framework has the potential to aid in teaching, improve multidisciplinary care, and provide a framework for interprofessional communication.

KEYWORDS
clinical skills, decision making, pharmacology

1 | INTRODUCTION

Diagnostic and management reasoning are two interrelated cognitive processes underlying health professionals' work.[1] Diagnostic reasoning studies have produced several cognitive models[2,3] supporting design of instructional strategies, curricula, and interventions aimed at reducing diagnostic errors.[4-8] Conversely, the literature lacks robust models for therapeutic reasoning, the portion of management reasoning focused on treatment selection.[9,10] While some have theorized that therapeutic reasoning may resemble diagnostic reasoning,[9,11] others[12] hypothesize that therapeutic reasoning is likely more complicated given the need to incorporate multiple, competing factors that rarely results in only one "correct" approach.

Few studies have explored how therapeutic reasoning occurs in health professionals other than physicians. Pharmacists are trained to provide safe and effective patient-centered therapeutics. Yet studies of pharmacists' therapeutic reasoning focus primarily on the "nonmaleficent" roles of pharmacists (ie, ensuring prescriptions do not harm patients), rather than "beneficent" roles (ie, developing efficacious therapeutic plans).[13,14] The pharmacist patient care process (PPCP) offers a framework for providing both safe and effective patient care using five steps: collecting, assessing, planning, implementing, and monitoring/evaluating effectiveness.[15] While the PPCP provides recommendations on *what* pharmacists should think about, this framework lacks guidance on *how* pharmacists should choose between therapeutic options.[16]

Decision-making around antimicrobial selection is particularly important because of the impact that individual prescribing choices have on antimicrobial resistance.[17,18] The general conceptual frameworks that exist in antimicrobial selection[19-21] do not consider the problem-solving inherent in expert practice, nor do they provide guidance about how antimicrobials should be chosen. Because effective antimicrobial stewardship practice requires close collaboration between physicians and pharmacists,[22,23] understanding similarities and differences in how physicians and pharmacists approach antimicrobial selection might promote more effective collaboration and improve patient care.

Previously, Abdoler and colleagues explored how internal medicine (IM) and infectious diseases (ID) physicians engage in therapeutic reasoning around antimicrobial selection (antimicrobial reasoning).[24] We aimed to further this line of inquiry in hospital-based pharmacists specializing in ID and other areas, to delineate their therapeutic reasoning approaches in comparison to what has been described in physicians.

2 | METHODS

We explored antimicrobial reasoning of hospital pharmacists from a postpositivist orientation,[25] and undertook a general qualitative approach.[26] From January through April 2019, we conducted semi-structured interviews of pharmacists practicing at the University of California, San Francisco Medical Center, a 600-bed academic medical center, and the Zuckerberg San Francisco General Hospital and Trauma Center, a 300-bed county hospital. The institutional review boards of both institutions granted our study exempt status.

2.1 | Participants

We invited pharmacists with a range of experience practicing in ID, IM, critical care, and emergency medicine to participate using purposive sampling to ensure a range of experience in these areas. We chose to study ID pharmacists because they collaborate with physicians to select, manage, and optimize antimicrobial regimens for complex patients requiring ID consultation. We also included non-ID pharmacists because they work with prescribers to make antimicrobial decisions for less complex cases. Both groups of pharmacists assist with antimicrobial treatment selection, evaluate physician-ordered therapies for appropriateness (order verification), and participate in formal and informal antimicrobial stewardship activities (eg, intravenous to oral conversion of medications, streamlining spectrum of activity).

2.2 | Vignettes and interview guide development

We made minor adaptations to the semi-structured interview guide developed by Abdoler and colleagues[24] to reflect pharmacists' scope of practice. Our interview guide (Appendix) included the same three clinical vignettes involving antimicrobial selection for community-acquired pneumonia, cellulitis, and urinary tract infection with bacteremia. Vignette prompts and probes garnered detailed responses about participants' reasoning processes. Participants also wrote out the steps of their reasoning process on note cards, arranging them in order and placing simultaneous steps side-by-side. Participants did not have access to informational resources during the interview. Finally, we asked participants questions about resources they use to support their antimicrobial selection decisions.

2.3 | Procedure

Participants meeting the criteria described above were invited to participate in the study via email. Participants were told the purpose of the study was to better understand how pharmacists make recommendations about antibiotic use in treating infections. Interested individuals were scheduled for a 60-minute interview based on their availability. Three investigators conducted and recorded interviews (E. A., K. G., C. M.) in-person. One investigator (E. A.) trained the other two investigators prior to starting the interviews. This investigator also led the first two interviews, while the other investigators (K. G. and C. M.) observed. The three investigators then proceeded to conduct all interviews individually.

2.4 | Analytic approach

A professional service transcribed recorded interviews. Dedoose 8.2.14 (SocioCultural Research Consultants, LLC, Los Angles, California) was used for coding. Two investigators (E. A., K. G.) began analyzing transcripts after the first interview, using the codebook developed by Abdoler and colleagues[24] as a sensitizing framework[27] for thematic analysis. Interviews continued alongside data analysis until multiple examples were identified for each code and no new codes emerged. Another investigator (C. M.) evaluated the updated codebook for clarity and refinement. E. A. and K. G. used the updated codebook to independently code each interview and then met seven times to compare code applications and resolve discrepancies, which were arbitrated by C. M.

These three investigators then used the same codebook to analyze the note card exercise, with each participant's response independently analyzed by two investigators. The three investigators met to compare their analyses, add new codes as needed, and then re-review the interview transcripts for evidence of new codes. The investigators then used the coded sequence data to generate an overall antimicrobial reasoning process and finalize the resulting themes.

2.5 | Reflexivity

The majority of our research team's members have expertise in ID and these professional identities influenced our interpretation of participants' responses in ways that both deepen our understanding and also may result in assumptions differing from participants' intent. Including pharmacists (K. G. and C. M.), physicians (E. A. and B. S.), and non-clinicians (B. O'B.) on our team provided a way to check our interpretations and minimize the risk of inferring beyond the data.

3 | RESULTS

3.1 | Participants

We interviewed 11 pharmacists, 5 ID pharmacists and 6 non-ID pharmacists representing a range of postgraduate clinical experience between less than 1 to over 15 years. Both groups of participants reported similar amounts of time dedicated to clinical care, with two participants in each group attributing less than 30% of their time to clinical care and the remainder spending more than 50% of their time providing clinical care. Three of the five ID pharmacists engaged in formal antimicrobial stewardship activities as part of their clinical time.

3.2 | Antimicrobial reasoning process

Pharmacists' antimicrobial reasoning encompassed three steps: *Naming the Syndrome*, *Delineating Pathogens*, and *Antimicrobial (Therapy Script) Selection*. *Naming the Syndrome* involved specifying or exploring the diagnosis. For many participants, this involved confirming the physician's diagnosis and ensuring an infection was present. *Delineating Pathogens* involved identifying or seeking to identify the microbes responsible for the clinical presentation, either specifically or by general organism classes. In *Antimicrobial (Therapy Script) Selection*, participants stated a therapeutic choice or range of choices, which included varying degrees of explanation. These steps were nearly ubiquitous in participants' descriptions of their reasoning processes across vignettes. While a few participants did not mention a particular step in any given vignette, all participants described each step at least once across the three vignettes and all participants selected an antimicrobial in every case.

3.3 | Factors impacting antimicrobial reasoning

Participants mentioned 23 different factors influencing their antimicrobial reasoning process across four groups: preexisting patient characteristics, current case features, provider and health system factors, and treatment principles (Table 1). Different factors impacted the reasoning process to varying degrees and frequencies, depending upon the participant and vignette.

3.3.1 | Preexisting patient characteristics

Participants considered how a patient's past medical history and social situation can affect the pathogens involved and/or antimicrobial choice. *Past infections* and patient *exposures* broadened or narrowed a participant's list of potential pathogens, often raising the specter of more resistant or atypical organisms. Participants described how patient factors (eg, *age*) made certain antibiotic regimens more or less desirable, while others, such as a patient's *ability to take oral medications* or *financial factors* influenced how participants anticipated administration and cost issues, respectively. Some factors, like *comorbidities* and *past exposure to antimicrobials*, influenced both pathogen determination and antimicrobial selection.

3.3.2 | Current case features

Participants also described how the clinical case affected their antimicrobial reasoning. *Differentiating features of the case*—such as exam findings or laboratory data—influenced which pathogens and antimicrobials participants considered. *Microbiologic data* (eg, cultures) helped participants define causative organisms and choose antimicrobials. The *severity of illness* led some participants to consider certain pathogens, while for others it influenced the route or antimicrobial classes they considered for treatment. In terms of *illness trajectory*, some participants mentioned that a patient's response to current

TABLE 1 Factors influencing antimicrobial reasoning

Factor and sub-factor	Examples from interviews [participant code]
Preexisting patient characteristics	
Age	For an 85 year-old woman, I like to avoid the fluoroquinolones…because they can cause tendon rupture and elderly patients are at increased risk for tendon rupture. [GP-105]
Allergies	… go to beta-lactam therapy by itself, ass uming he is not allergic…[GP-110]
Exposures	I do not believe that she's had any hospital admissions or exposure to the health care setting…so I would consider it to be a community-acquired pneumonia. [GP-106]
Medical history	
Ability to take oral drugs	Are they able to take PO meds…do I need to think about IV antibiotics, enteral absorption of PO antibiotics? [GP-103]
Comorbidities	She has some comorbidities that put her at risk for some toxicities…associated with trimethoprim-sulfa, like her type 2 diabetes and her recent kidney injury… [IDP-107]
Past infections	Has he had previous infections…that might be contributing to this infection? [GP-110]
Medications	
Prior exposure to antimicrobials	…strong predictors of multidrug resistance are…antibiotic exposures [IDP-111]
Current medications	…I'm going to stay away from things that prolong the QT interval, because she's on methadone… [GP-110]
Existing pill burden	Cephalexin, I think it's 3 times a day…Septra's twice a day so it's easier to remember with her morning and evening meds. [GP-105]
Social factors	
Ability to adhere	…I'm also considering their ability to be compliant with the medication regimen. [GP-103]
Financial factors	Based on his insurance, the next step to think about is what's available to him from a cost standpoint. [GP-106]
Current case features	
Differentiating case features	…purulent cellulitis vs nonpurulent cellulitis, the pathogens can be slightly different, and then your coverage can also certainly be different. [GP-106]
Microbiologic data	I would review any culture data…to better target antibiotic therapy to whatever the patient's organism is. [IDP-109]
Severity of illness	The severity of illness can kind of dictate how aggressive you want to be with therapy…suggests the types of pathogens that you might be more concerned about based on severity. [GP-106]
Trajectory of illness	The way I would assess or select which antibiotics to send this patient home on are to assess how he's clinically improved on his current regimen. [IDP-109]
Provider and health care system factors	
Antibiogram	…our in-house antibiogram has very good susceptibility, and that's why we picked it [ceftriaxone] as our core agent. [IDP-102]
Clinical experience	I definitely would not feel comfortable with Keflex. I know some people would but, personally not for bacteremia associated with urosepsis. [IDP-101]
Institution-specific practices	…typical regimen for community-acquired pneumonia…would be ceftriaxone and azithromycin…at our hospital we use doxycycline for atypical coverage.[IDP-107]
Team dynamics	…talk it over with the team…and then say here is what I would suggest…[IDP-101]
Treatment principles	
Pathogen-based treatment	…doxycycline or azithromycin to cover the atypical bugs…ceftriaxone to cover strep pneumo, and other Gram-negatives… [GP-104]
Evidenced-based/guideline-supported decisions	…azithromycin has to be tied back to what's stated in some of the guidelines and also reimbursement… to bill for a community acquired pneumonia in the ICU, you should be on azithromycin rather than doxycycline. [GP-104]
Narrow coverage	…select an antibiotic…as narrow as possible [IDP-111]
Parsimony	…I feel fine with levofloxacin…instead of doing…cefpodoxime plus doxy…[GP-203]

Abbreviations: GP, general practitioner; ICU, intensive care unit; IDP, Infectious diseases pharmacist; IV, intravenous; PO, oral.

antimicrobial therapy helped to refine the microbiologic differential; others noted that they considered the degree of improvement on intravenous therapy before recommending stepdown therapy to an oral medication.

3.3.3 | Provider and health care system factors

Participants mentioned several provider and health care system factors that influenced their antimicrobial reasoning. Some participants

drew upon their *clinical experience* when choosing between antimicrobials. Others discussed how *team dynamics*—including understanding the physician thought processes underlying antimicrobial choice and recognizing the practices of different teams—and their desire to support these dynamics going forward were important aspects of their antimicrobial decision-making.

3.3.4 | Treatment principles

Participants' antimicrobial reasoning was guided to varying degrees by different underlying prescribing principles, all of which related to treatment choice. Some participants mentioned specifically the need to choose antimicrobials directed toward the likely pathogens (*pathogen-based treatment*), while others stated that the antimicrobial regimen needs to involve as few agents as possible (*parsimony*). Participants also prioritized antimicrobial choices that were supported by evidence, guidelines, or regulatory bodies (*evidence-based/guideline-supported decisions*).

3.4 | Antimicrobial (therapy) script content

Participants described 14 different drug characteristics affecting antimicrobial choice, encompassing a therapy script that represented participants' prior knowledge of a particular medication (Table 2). Participants considered these static medication features both independently and in reference to the clinical factors present in the case. For instance, if participants raised concerns about a patient's ability to adhere to an antimicrobial regimen, they would discuss antimicrobial dosing.

3.5 | Resources

Participants named a variety of resources they use to support antimicrobial reasoning decisions. In addition to the antibiogram mentioned previously, participants used both internal (eg, local empiric infection treatment guides) and external resources (eg, Sanford Guide, Lexicomp, national treatment guidelines). Some referred to primary literature and Clinical and Laboratory Standards Institute guidance.

3.6 | Antimicrobial reasoning framework

Through our analysis, we developed an antimicrobial reasoning framework consisting of three steps: *Naming the Syndrome*, *Delineating Pathogens*, and *Antimicrobial (Therapy Script) Selection*, though this process was not always linear (Figure 1). For example, after *Naming the Syndrome*, some participants "revisited the syndrome" in light of new clinical data. *Pre-existing patient characteristics* and *current case features* affected the delineation of pathogens and antimicrobial choice, while *provider and healthcare system factors* and *treatment principles* primarily influenced antimicrobial choice. Many participants described how these factors interplayed with specific aspects of the therapy script (drug characteristics) to inform antimicrobial choice.

TABLE 2 Antimicrobial (therapy) script content

Drug characteristic and sub-characteristic	Example excerpts from interviews (participant code)
Adverse effects	Quinolones in an elderly person is not the best either because of the potential for CNS toxicity… [IDP-101]
Cost and pharmacy considerations	…super long-acting Vanco-like agents [are] …nonformulary. We probably do not want to go the nonformulary approval route. [GP-104]
Dosing	Cipro is twice daily, levo is once daily… [GP-108]
Duration of therapy	I'd probably do…trimethoprim-sulfa because…[the patient] would not probably experience a lot of toxicity in a shorter amount of time. [IDP-107]
Drug–drug interactions	Fluoroquinolones…[have] QTC prolongation in combination with Methadone so that would be something that I would consider… [GP-106]
Evidence of efficacy/ guideline support	…could consider cefpodoxime, the only thing is I'm not sure if it has a urine indication. [IDP-101]
Monitor adverse effects	…he will need more monitoring if we… send him out on IV Vancomycin [GP-104]
Pharmacodynamics	…doxy having good MRSA coverage [IDP-102]
Pharmacokinetics	Nitrofurantoin is an antibiotic that can be used for UTI, but we would not want to use it for a systemic infection like a bacteremia, or even for a pyelonephritis just because of its pharmacokinetics. [IDP-109]
Bioavailability	Cefpodoxime actually has much better bioavailability than cefdinir. [IDP-101]
Drug distribution	Am I treating a CNS infection? That is going to affect whether I use things to penetrate the CNS or not. [GP-110]
Clearance/ metabolism	…does he have like a reasonable [creatinine] clearance? And if that were true, I'd probably do something like trimethoprim-sulfa because…he would not probably experience a lot of toxicity… [IDP-107]
Route of delivery	…she would be a candidate for transition to PO antibiotic. [IDP-109]
Spectrum	…we are trying to choose the narrowest spectrum antibiotic PO option… [GP-102]

Abbreviations: CNS, central nervous system; IDP, infectious diseases pharmacist; IV, intravenous; GP, general practitioner; MRSA, methicillin-resistant *Staphylococcus aureus*; PO, oral; UTI, urinary tract infection.

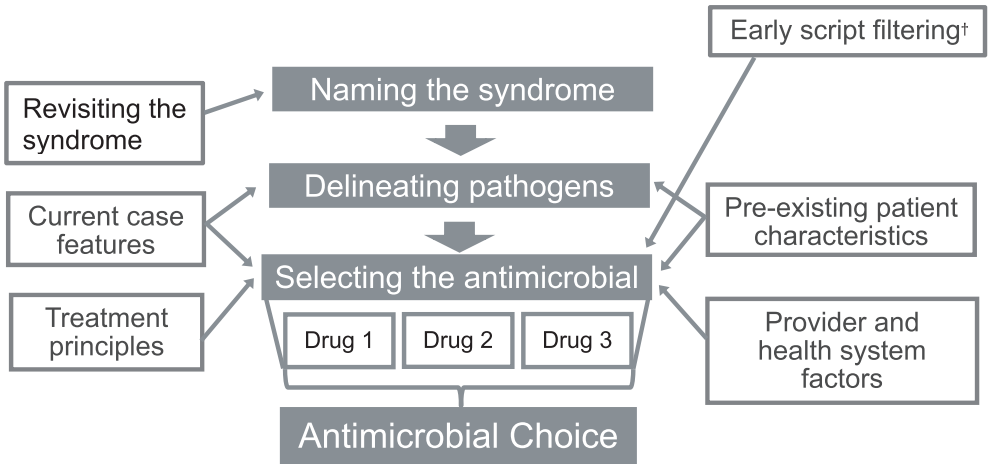

FIGURE 1 Antimicrobial reasoning framework. Though this process generally was found to be linear, some participants reported these steps in a different order. We chose to represent the most common configuration of the steps for the purpose of the figure. †Some participants mentioned *Early Script Filtering*, which affected their antimicrobial choice, prior to *Naming the Syndrome*. This was a new antimicrobial reasoning step that differed from those previously described by physicians[24]

Some participants were explicit in describing the connection between steps. The syndrome evokes a particular antimicrobial differential, which is broadened or narrowed in considering patient characteristics and case features. In turn, this list of potential pathogens dictates antimicrobial options, the individual features of which are considered alongside patient, case, institutional confines, and the participants' own practices. However, others merely referenced the steps without specifically delineating their connection.

Some participants mentioned one additional step, *Early Script Filtering*, that occurred prior to *Naming the Syndrome*. *Early Script Filtering* involved participants considering certain factors—such as microbiologic data or patient allergies—that constrained antimicrobial options from the very first stages of the reasoning process.

4 | DISCUSSION

We identified a framework for pharmacists' antimicrobial therapeutic reasoning, which encompassed three steps and was influenced by 23 factors. We also described 14 drug characteristics included in antimicrobial therapy scripts. Participants provided examples of both nonmaleficent (eg, avoiding adverse effects from specific antimicrobials) and beneficent (eg, recommending medications with evidence of efficacy/guideline support) factors affecting their treatment choices, which further supports the pharmacists' role in these two domains.[13,14,28]

Participants in this study generally engaged in the same antimicrobial reasoning steps previously described by physicians.[24] One possible explanation for this finding is that both studies recruited participants from the same hospitals. Because participants in both studies mentioned health care system factors as guiding their reasoning processes, the practice environment may have resulted in similarities between the physician and pharmacist reasoning frameworks. Additionally, the vignettes in this study simulated therapeutic selection scenarios that pharmacists frequently encounter while working collaboratively with physicians, which may have also influenced the alignment of reasoning processes across these two participant groups.

We noted one additional antimicrobial reasoning step described by our participants that differed from those previously described by physicians.[24] Some pharmacists used patient or case features to narrow treatment options before naming the syndrome (*Early Script Filtering*). This behavior aligns with the pharmacists' role in evaluating medication appropriateness,[29] where certain factors (eg, pre-existing medications, allergies, organ function) render a medication inappropriate or unfavorable for a given patient. As an inherent aspect of pharmacy practice, participants may have chosen to incorporate these factors earlier in their reasoning process to rule out inappropriate therapies. Our results indicated that both ID and non-ID pharmacists engaged in this early script filtering process, supporting the notion that a pharmacist's role in evaluating medication appropriateness transcends all specialty practice areas. Some pharmacists discussed confirming the physician's diagnosis as part of *Naming the Syndrome*, reflecting pharmacists' antimicrobial stewardship role in auditing medication orders for appropriateness.[22]

Pharmacists in our study identified one factor, *team dynamics*, in their antimicrobial reasoning that did not appear in physicians' antimicrobial reasoning.[24] *Team dynamics* illustrates the collaborative role of pharmacists in antimicrobial decision-making,[22] where participants mentioned working with prescribers to understand case features that affect antimicrobial selection. Our participants also expanded on two factors previously mentioned by physicians[24]: *evidence-based/guideline-supported decisions* and *ability to adhere*. Under *evidence-based/guideline-support*, pharmacists added that treatments should be supported by regulatory bodies and/or payers, reflecting pharmacists' attention to evidence-based and less costly medications, respectively. Under *ability to adhere*, pharmacists added that a patient's predetermined disposition can influence the type of chosen regimen, which highlights the pharmacist's role in planning for transitions of care beyond the hospital setting.[30]

There were also several factors (*likelihood of follow-up*, *patient preferences*, and *supporting trainee choices*) and one therapy script characteristic (*safety in pregnancy*) that physicians previously mentioned[24] but our participants did not. Participants in this study

described several social factors that impacted their reasoning (eg, financial factors and social support), but these factors did not clearly involve the patient's preference nor likelihood of follow-up. It is possible these two factors did not arise in our participant's reasoning processes due to practicing in a hospital setting where pharmacists may have limited direct patient contact. Participants also did not mention supporting trainee choices, but the *team dynamics* factor seemed related insofar as pharmacists sought to support the choices of physicians whenever safe and possible. *Safety in pregnancy* was not part of our participants' therapy script, although it is worth noting that the vignettes did not include any individuals of childbearing age.

Our antimicrobial reasoning framework aligns with two proposed models of therapeutic reasoning.[13,28] Wright and colleagues previously describe three steps: reasoning through medication options based on relevant factors, judging the risks and benefits of these options, and deciding which medication to prescribe.[28] Participants in our study completed these three steps when mentioning key factors, weighing medication risks and benefits in their therapy script, and selecting an antimicrobial. Participants also described the importance of team dynamics and collaborative decision-making while reasoning through cases. Croft and colleagues highlight the role of "collaborative planning" in community pharmacists' reasoning, though participants in their study described collaborating with patients rather than other health care providers.[13] Wright and colleagues also offered a collaborative therapeutic reasoning model where pharmacists and other health care professionals conduct independent clinical reasoning and judgments, followed by a joint therapeutic decision.[28]

One key component missing from our reasoning model, but mentioned in other models,[13,31] is a reflective or metacognitive process. Marcum describes a clinical reasoning model where providers reflect upon their intuition/experience and logic/critical thinking both before and after making a clinical decision.[31] It is possible participants in our study did not describe this process due to their familiarity with the management of these common infections, or because the act of explaining their reasoning process fulfilled the same metacognitive purpose.[32] Nonetheless, given the role of metacognition in developing clinical expertise,[33] a therapeutic reasoning model aimed at instructing trainees or early practitioners would likely benefit from the inclusion of an explicit metacognitive step in the reasoning process.

This framework has potential applications to aid in teaching pharmacy students how to reason through therapy choices. Given the similarities we found between pharmacist and physician antimicrobial reasoning processes, there are also potential applications for interprofessional education and practice. With a shared model across professions, this framework could be used to facilitate communication around antimicrobial selection between disciplines and augment stewardship efforts around antimicrobial prescribing.

4.1 | Limitations

We used the vignettes in this study because they illustrated common antimicrobial reasoning scenarios and common infectious syndromes. However, it is unlikely this study identified all possible factors impacting pharmacists' antimicrobial reasoning process, in part due to the failure of the vignettes to trigger consideration of certain factors (eg, pregnancy). Additionally, these cases focused on antimicrobial selection rather than evaluation of pre-existing antimicrobial prescriptions. Thus, this framework may not adequately represent pharmacists' reasoning process for antimicrobial medication review and may limit application to settings where this is the pharmacists' primary role/focus. Future studies may consider providing a larger variety of cases with a broader range of patient characteristics, case features, and pharmacist roles (medication selection vs review). This study also took place at two local institutions, which may limit applicability to other locales. Additionally, while individuals engaging in antimicrobial stewardship were included, this study was not designed to identify how engagement in antimicrobial stewardship specifically may impact antimicrobial reasoning processes.

5 | CONCLUSION

We identified a framework for pharmacists' antimicrobial therapeutic reasoning that is similar to physicians' reasoning processes. Differences we identified in physician and pharmacist reasoning may be due to pharmacist's unique role in several areas, such as evaluating medication appropriateness and antimicrobial stewardship. This framework could be applied to didactic and clinical instruction of antimicrobial therapeutic reasoning and interprofessional practice.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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